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Odelros

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(54) **METHOD AND DEVICE FOR PREVENTING DISTRIBUTION OF FIRE GASES IN A VENTILATING SYSTEM**

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(52) **U.S. Cl.** **169/56**; 169/60; 169/48; 169/45; 454/255; 454/369; 236/49

(58) **Field of Search** 169/45, 43, 48, 169/49, 56, 60, 61; 454/369, 255; 236/49

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(57) **ABSTRACT**

A method and device for preventing distribution of fire gases in a ventilating system that serves a number of fire compartments (**15, 16**), the ventilating air, during normal operating conditions, having a certain predetermined direction of flow at the inlet side and the outlet side of the fire compartments (**15, 16**). It is significant that when a predetermined lowest pressure drop is registered, for the ventilating air in the direction of flow, over a measuring spot at the inlet side or the outlet side, a blocking is effected of the flowing area of the ventilating air past the measuring spot.

5 Claims, 6 Drawing Sheets

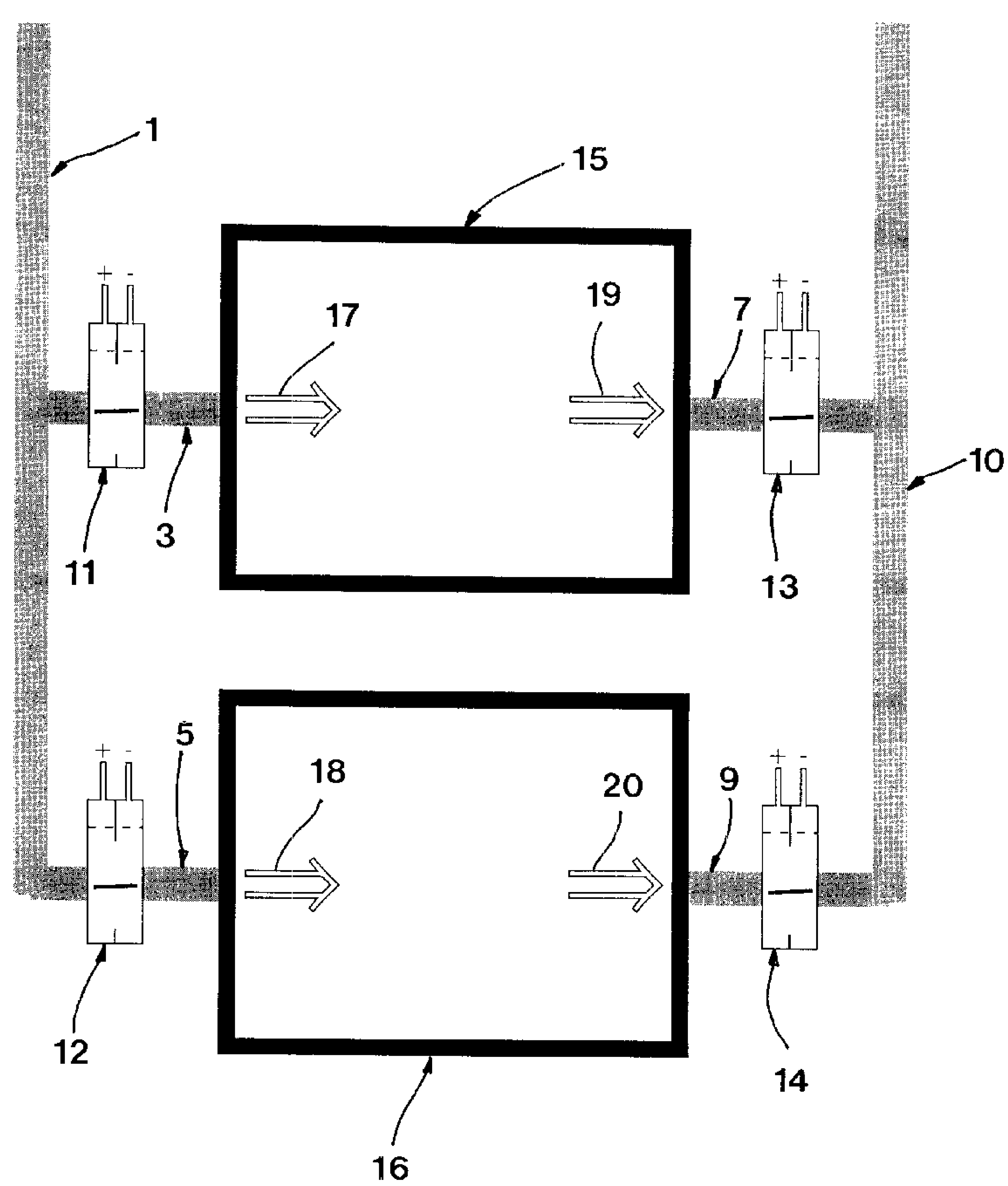


Fig 1

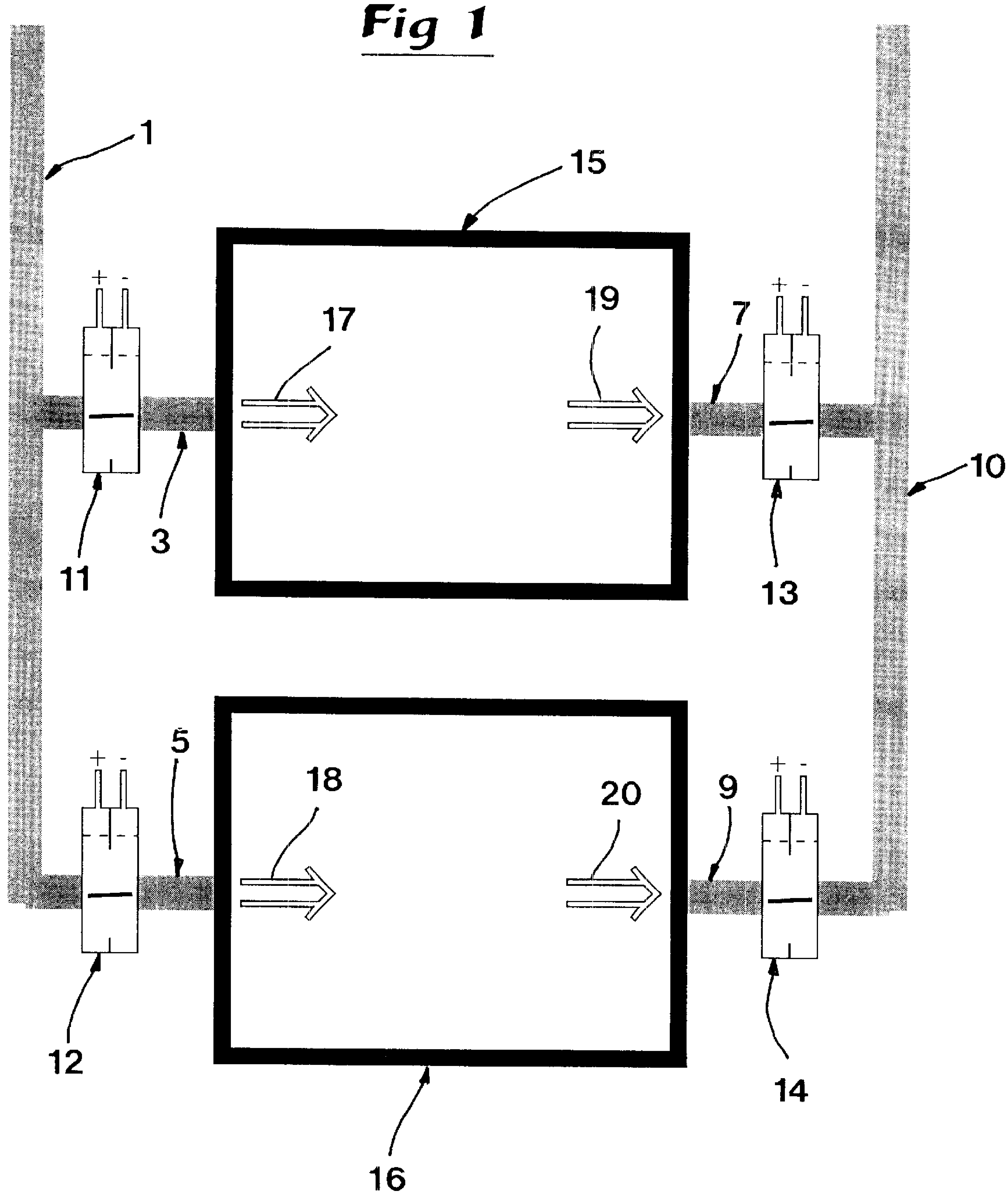


Fig 2

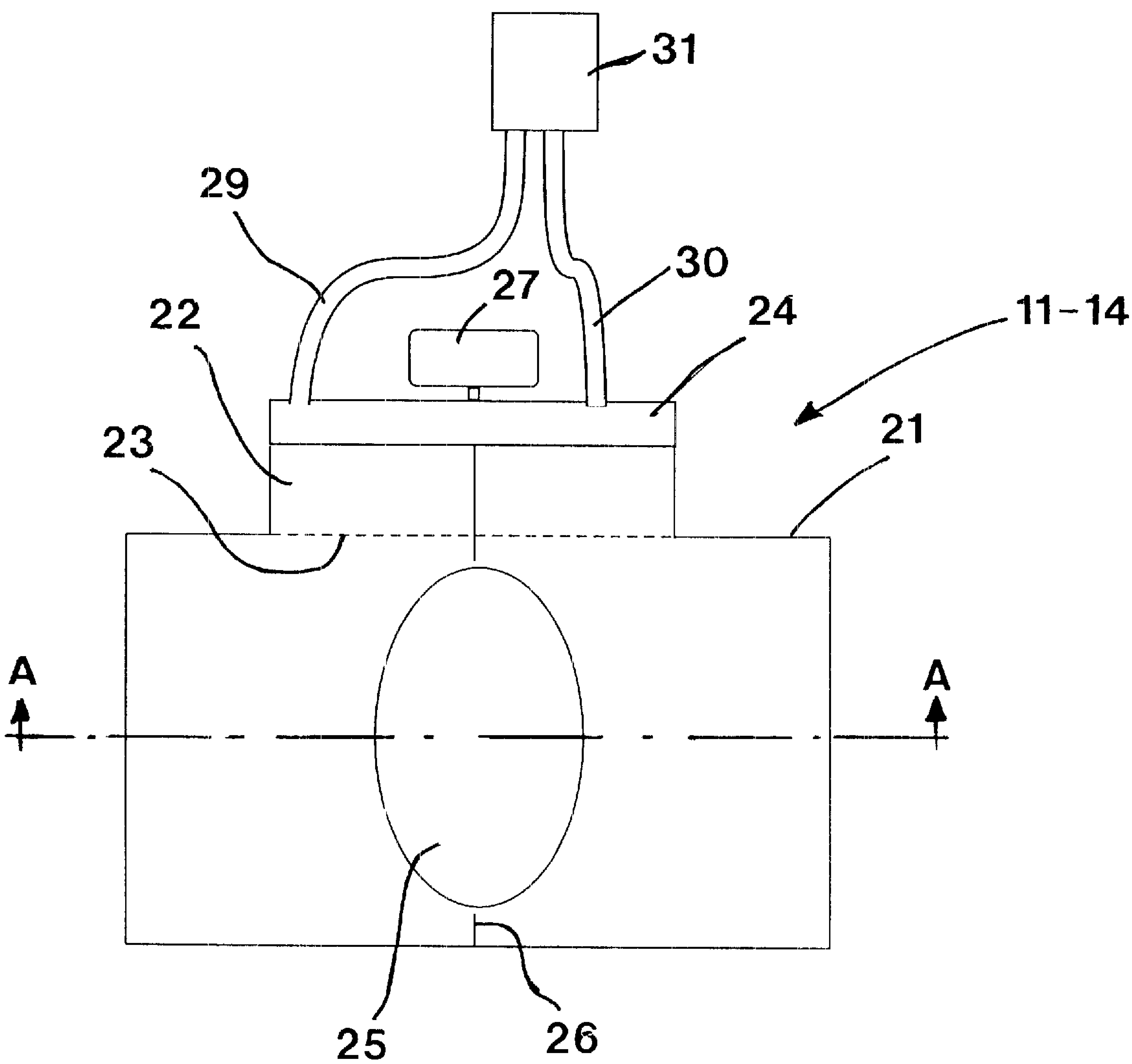


Fig 3

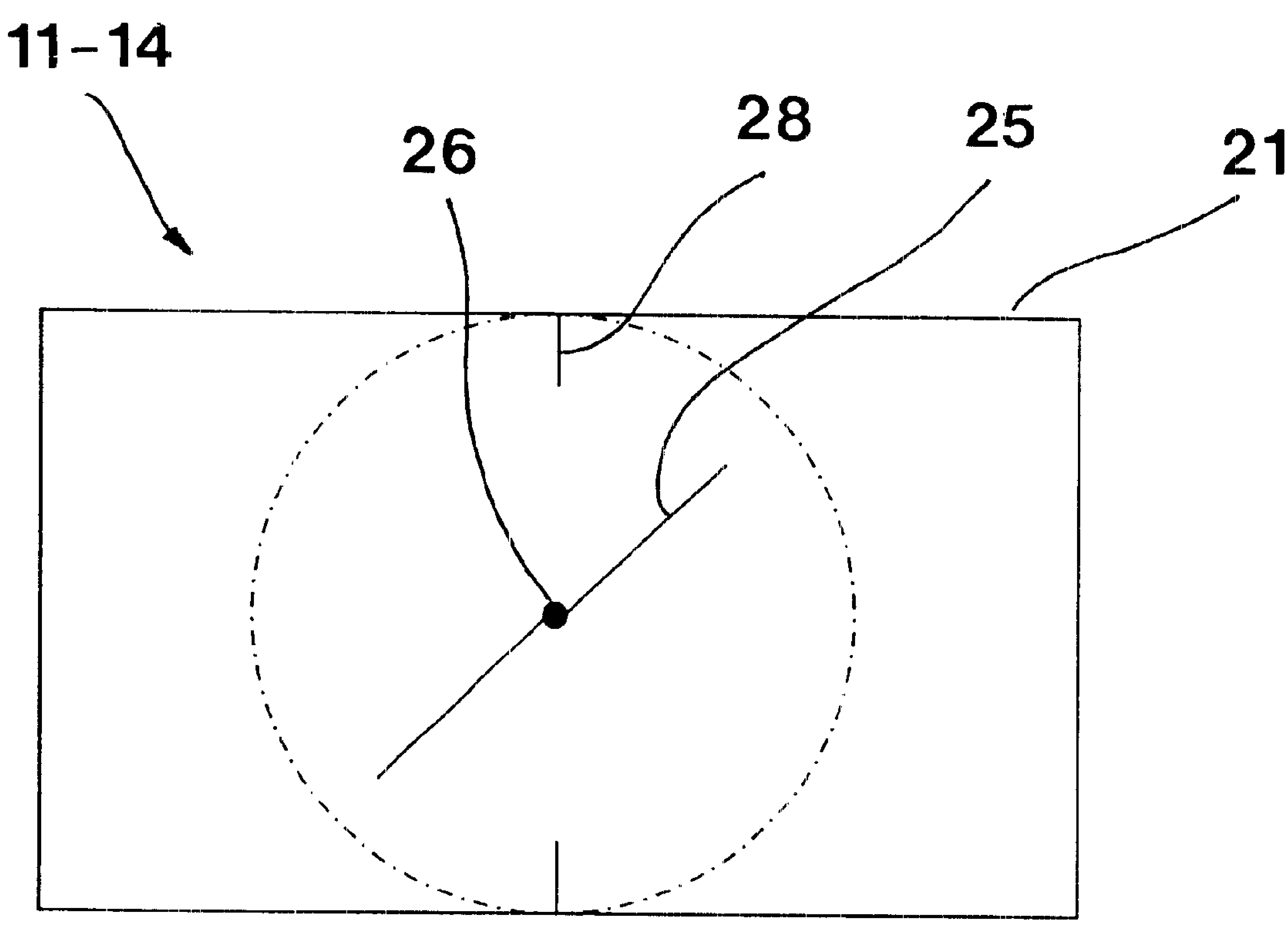
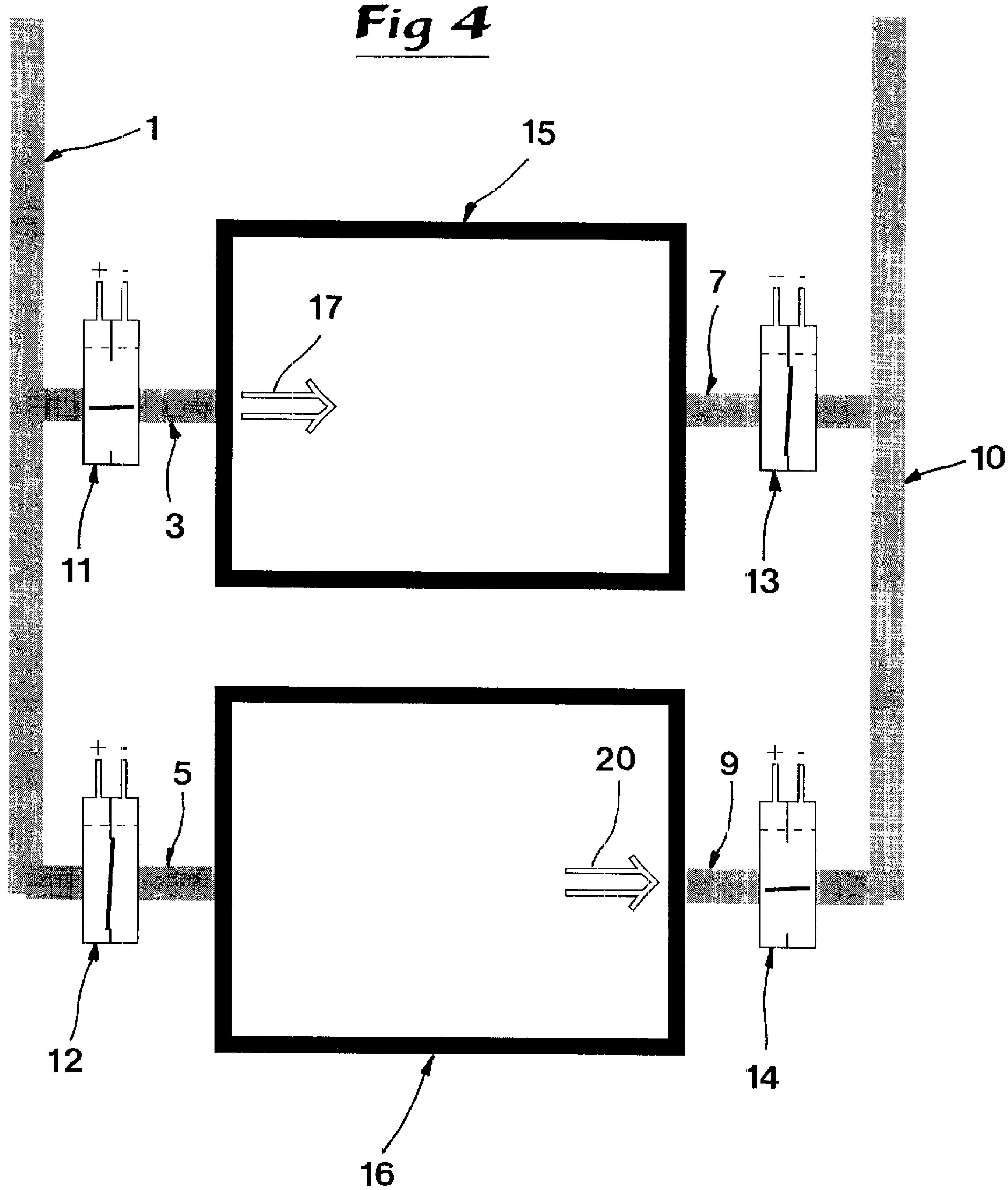


Fig 4



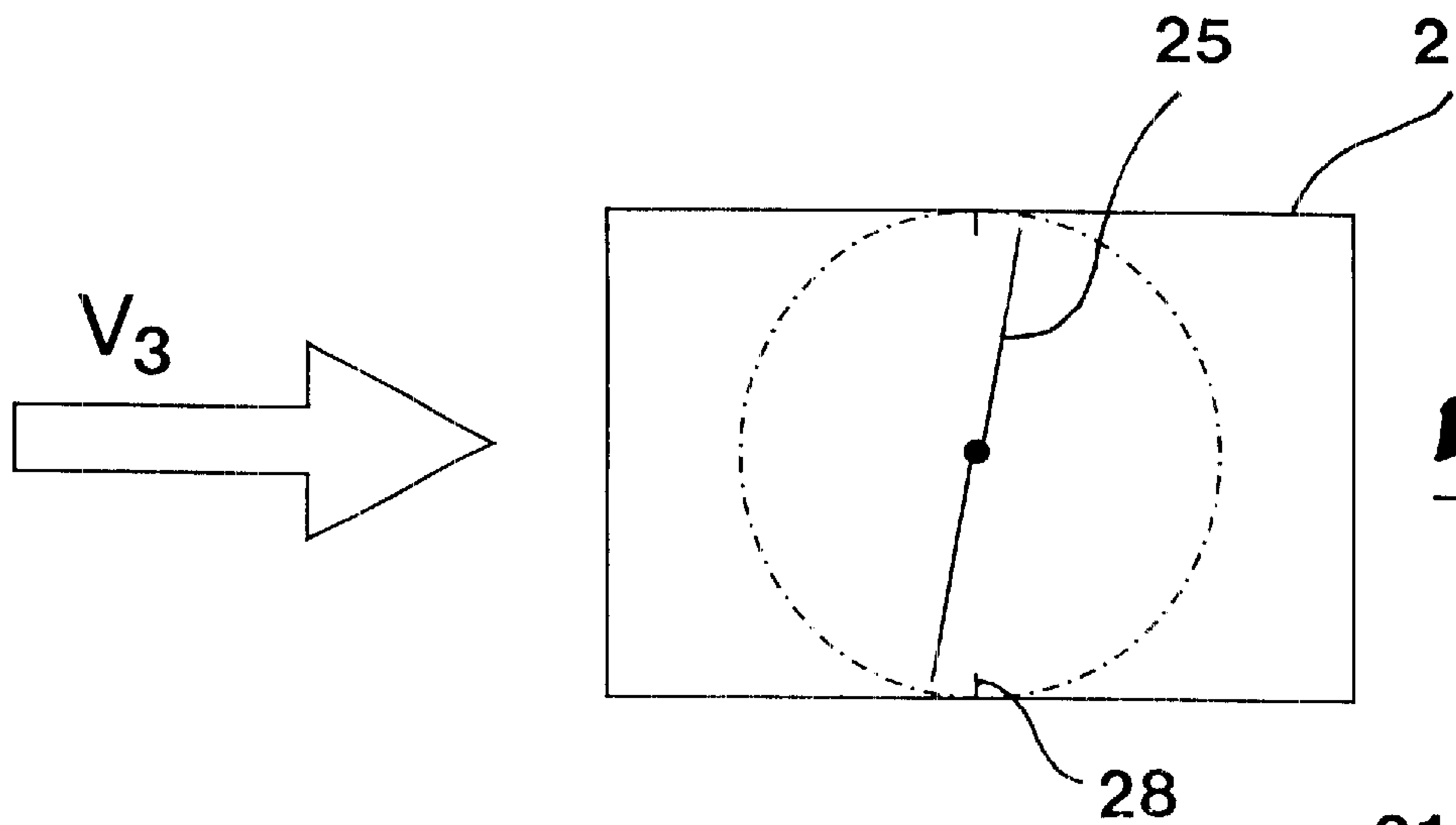


Fig 7

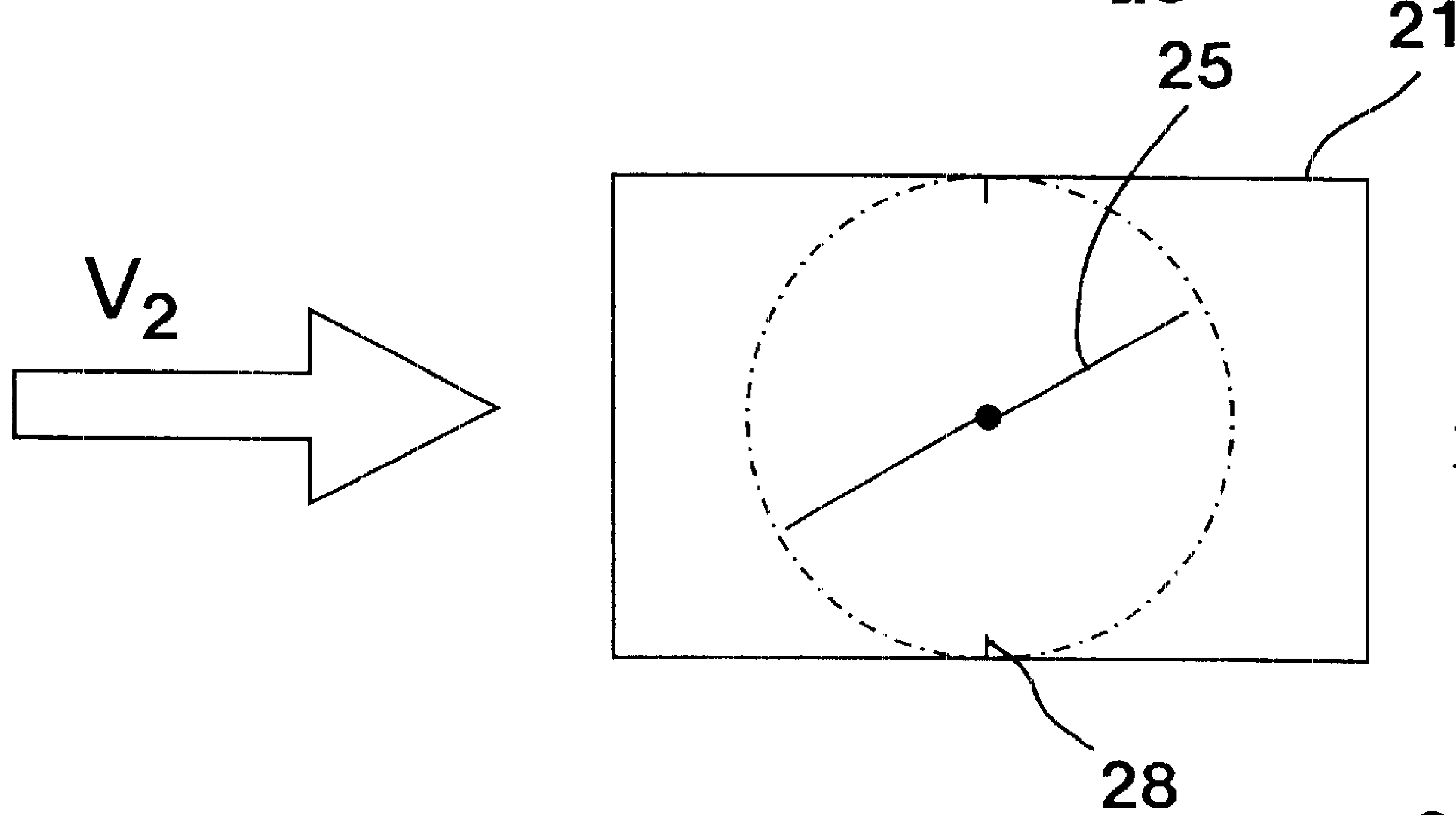


Fig 6

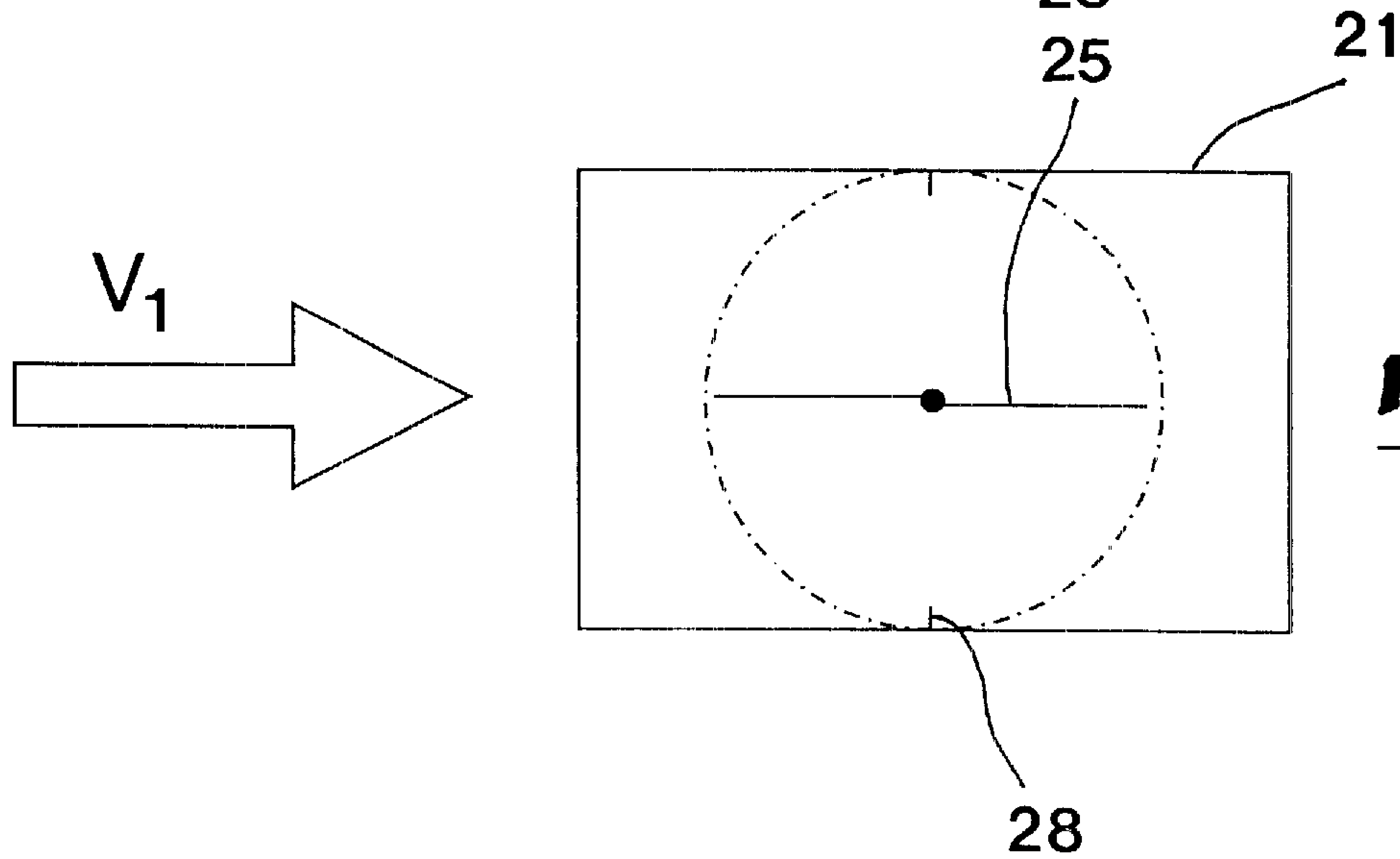


Fig 5

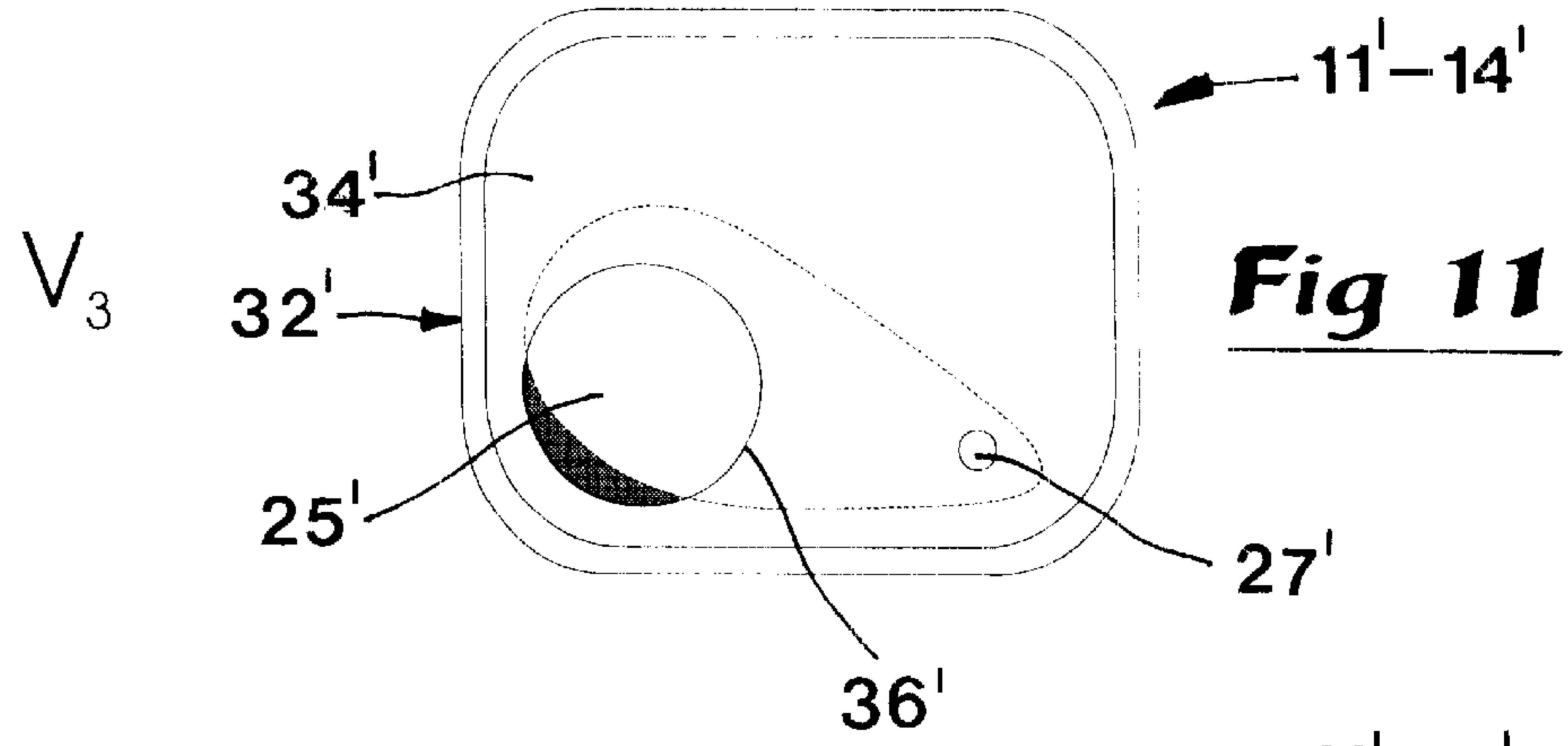


Fig 11

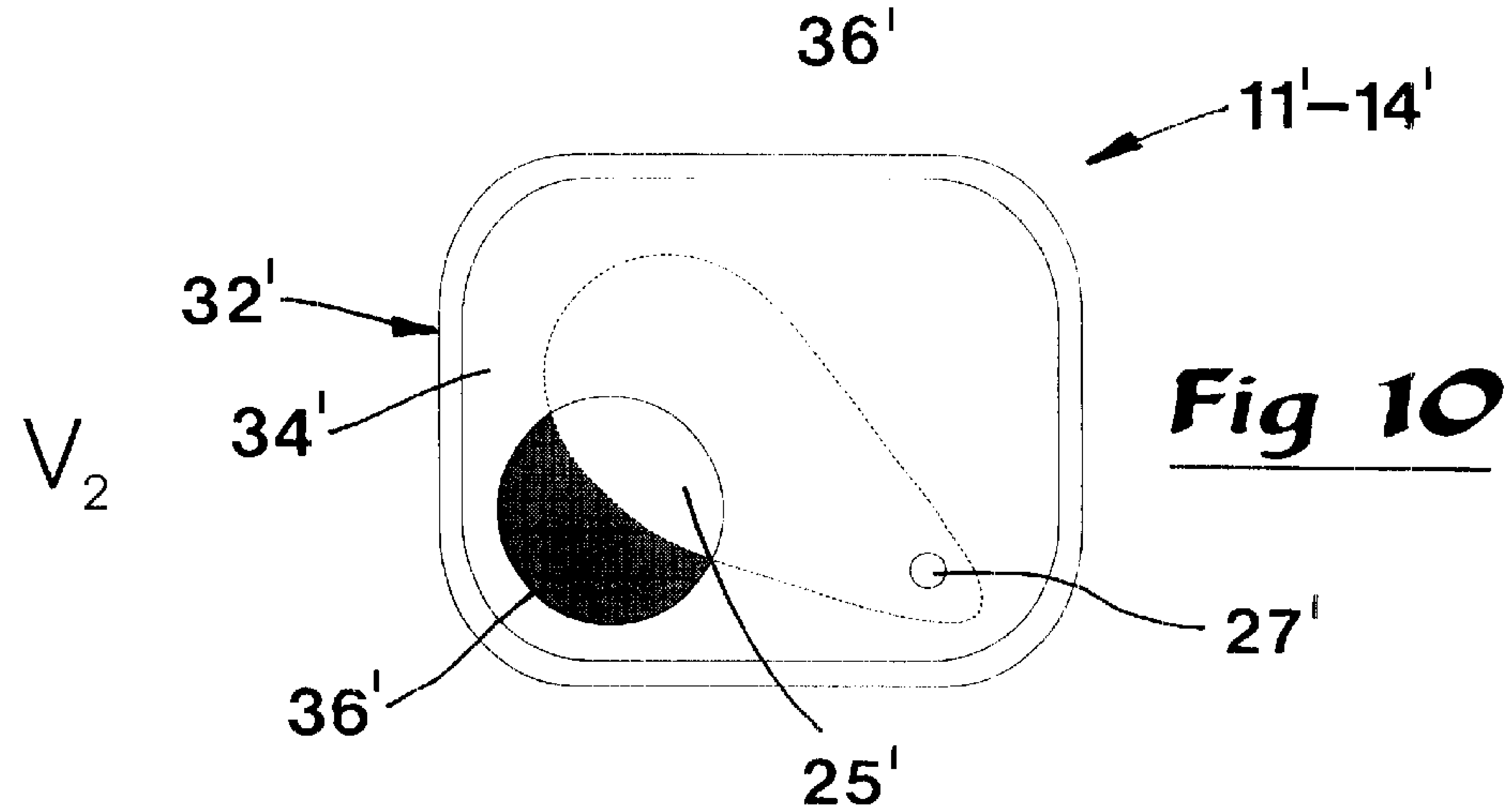


Fig 10

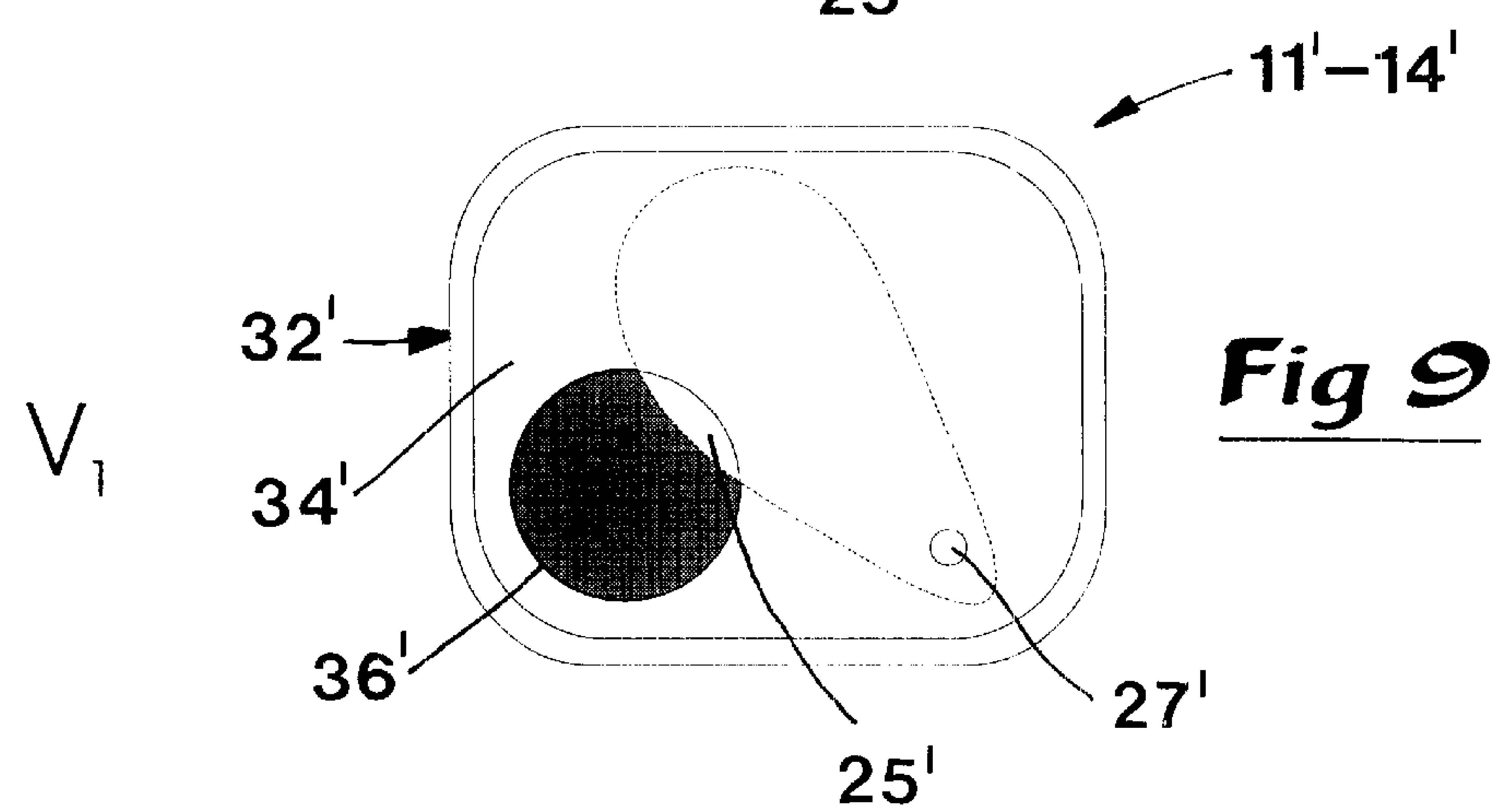


Fig 9

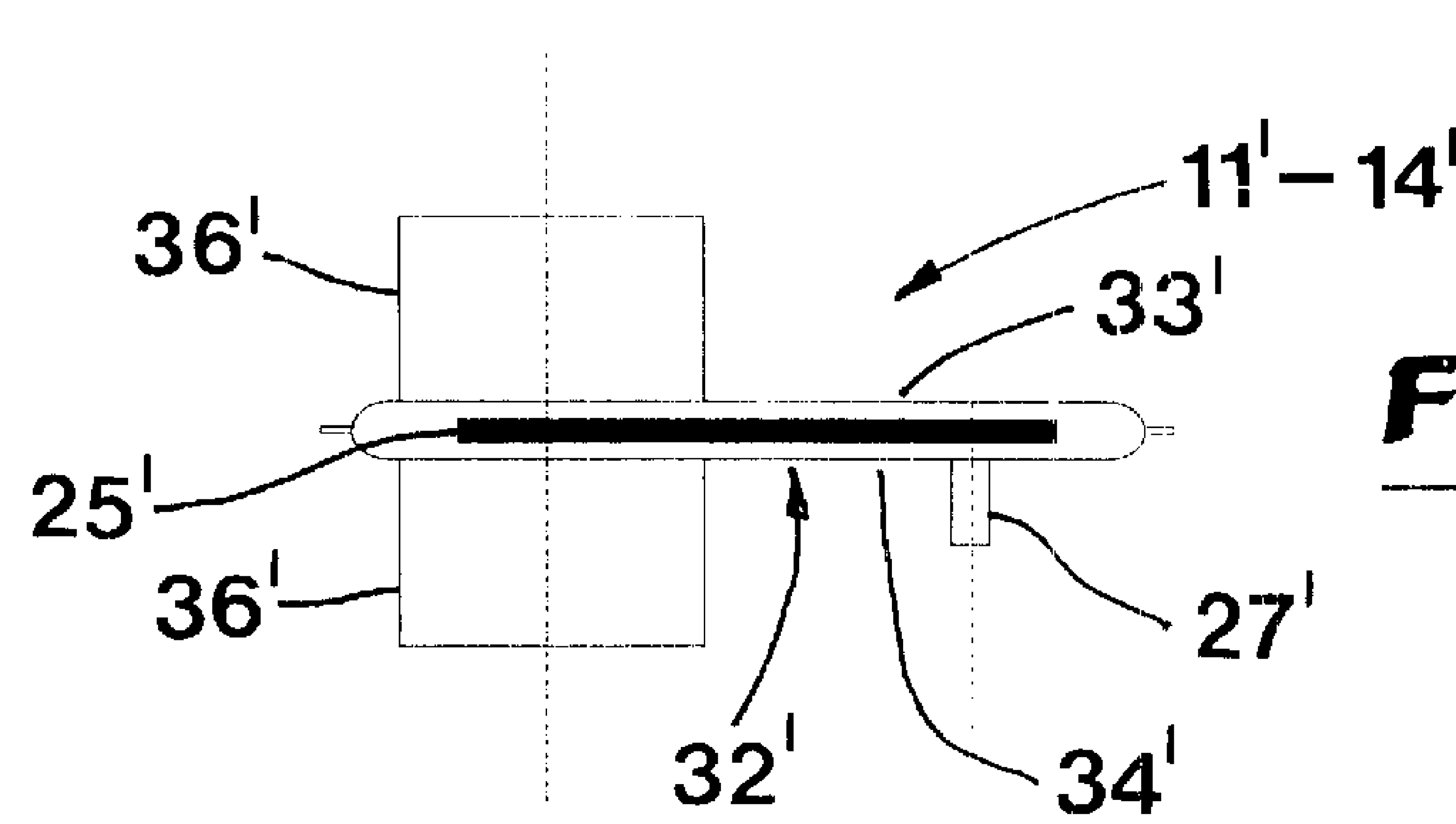


Fig 8

METHOD AND DEVICE FOR PREVENTING DISTRIBUTION OF FIRE GASES IN A VENTILATING SYSTEM

CROSS REFERENCE TO RELATED APPLICATION

This is the 35 USC 37 national stage of International Application PCT/SE00/00086 filed on Jan. 18, 2000, which designated the United States of America.

TECHNICAL FIELD OF THE INVENTION

The present invention relates to a method and a device for preventing distribution of fire gases in a ventilating system that serves a number of fire compartments, the ventilating air, during normal operating conditions, having a certain predetermined direction of flow at the inlet side and the outlet side of said fire compartments.

PRIOR ART

From SE-B-442 338 a device adapted to prevent distribution of fire gases in a ventilating system is previously known. This device relies on the principle that self actuated non-return valves, arranged in the ducts of the ventilating system, are kept open by a pressure drop that is present over said valves, said pressure drop being generated by a fan device allotted to said ventilating system. Each of said valves are arranged to automatically close when the pressure drop ceases. If such a valve is arranged at the inlet side of a fire compartment and a pressure is developed in said fire compartment, e.g. in connection with a fire, said pressure may remove the pressure drop over the valve, said valve automatically closes and the supply of ventilating air to the fire compartment ceases. Air is sucked out through the valve at the outlet side as long as the fan device is operating. This sucked out air is not able to enter any other fire compartment due to the valve that is arranged at the outlet side of the other fire compartments.

The arrangement described above has the disadvantage that an accurate mounting of the valves is necessary since their function relies on the attraction of gravity. Further, energy losses are present if the valves are to open at air flows of low velocity.

Ventilating systems with non-return valves are previously known from SE-B-459 522 and SE-B-460 434, said non-return valves being developed from the device according to SE-B-442 338, said device thus aiming at the prevention of distributing fire gases. The further developed ventilating systems are also aiming at the prevention of fire distribution. In order to realize this the non-return valves are equipped with a heat sensitive means, e.g. a fuse, that releases a closing of the non-return valves when the temperature adjacent the valves exceeds a certain value.

It is also previously known to register the presence of fire gases in a ventilating system by providing smoke detectors in the ducts of the ventilating system. However, a number of disadvantages are connected with said smoke detectors. Firstly, it should be mentioned that it is difficult to position the smoke detectors, especially if they are to detect smoke from several fire compartments. A further disadvantage is that the function of the smoke detector depends on the type of smoke that is generated, i.e. the smoke detector indicates only for certain type/types of smoke. This means that it is extremely complicated to check whether a smoke detector functions. Further, the smoke detector normally does not indicate until the duct is filled with smoke. Unsuccessful positioning or a quick fire progress may cause extensive fire damages in other fire compartments. In this connection it should also be considered that the smoke detector is comparatively expensive.

OBJECTS AND FEATURES OF THE INVENTION

A primary object of the present invention is to define a method and a device that in an effective way prevent distribution of fire gases in a ventilating system.

According to a preferred embodiment the principle of the present invention may also be used in connection with varying air velocities in the ventilating system.

A further object of the present invention is that indication in order to prevent fire distribution should also be effected.

At least the primary object of the present invention is realized by means of a method and a device that have been given the features of the appending independent claims. Preferred embodiments of the invention are defined in the dependent claims.

BRIEF DESCRIPTION OF THE DRAWINGS

Below embodiments of the present invention will be described, reference being made to the accompanying drawings, where:

FIG. **1** shows a schematic view of a ventilating system according to the present invention, said ventilating system being connected to two fire compartments;

FIG. **2** shows a schematic side view, in enlarged scale, of a ventilating means that is incorporated in the to ventilating system;

FIG. **3** shows a section along A—A in FIG. **2**;

FIG. **4** shows a schematic view of the ventilating system according to FIG. **1**, where two of the valves are closed;

FIGS. **5–7** show schematically the valve means according to FIG. **2** at different operating conditions of the ventilating system;

FIG. **8** shows schematically an alternative embodiment of a ventilating means; and

FIGS. **9–11** show schematically the ventilating means according to FIG. **8** at different operating conditions of the ventilating system.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS OF THE PRESENT INVENTION

The ventilating system, shown schematically in FIGS. **1** and **4**, comprises a main duct **1** for supply air, a first and a second branch duct **3** and **5** respectively for supply air, a first and a second branch duct **7** and **9** respectively for exhaust air and a main duct **10** for exhaust air. A first valve means **11** is provided in the first branch duct **3** for supply air, a second valve means **12** is provided in the second branch duct **5** for supply air, a third valve means **13** is provided in the first branch duct **7** for exhaust air and a fourth valve means **14** is provided in the second branch duct **9** for exhaust air. The plus signs and the minus signs, + and − respectively, of each valve means **11–14** symbolize that the pressure drop of the ventilating air is measured over the valve means **11–14**.

In FIG. **1** the ventilating system according to the present invention is connected to a first and a second fire compartment **15** and **16** respectively, the arrows **17–20** symbolize the normal direction of flow of the air in the ventilating system, i.e. ventilating air is supplied to the fire compartments **15** and **16** via the main duct **1** and the branch ducts **3** and **5** while ventilating air is exhausted from the fire compartments **15** and **16** via the branch ducts **7** and **9** and the main duct **10**. In order to effect flow of the ventilating air according to the arrows **17–20** the ventilating system according to the present invention also comprises air transporting means, e.g. fans, that are not disclosed in FIG. **1**.

In the disclosed embodiment the valve means **11, 12, 13** and **14** are of the type where a damper of each valve means is pivotally mounted, said damper may seal against abutments of the valve means. A preferred valve means will be described schematically with reference to FIGS. **2** and **3**.

In each of the branch ducts **3–9** a valve means **11–14** according to FIG. **2** and **3** is provided. Said valve means **11–14** comprises a duct portion **21** that he is intended to constitute a portion of respective branch duct **3–9**. Above the duct portion **21** in FIG. **2** a chamber **22** is provided, said duct portion **21** and the chamber **22** being defined by a perforated metal sheet **23**. The chamber **22** also has a lid **24** that can be removed from the chamber **22** for inspection and service. A damper **25** of the valve means **11–14** is pivotable around a shaft **26** that extends through the chamber **22** and the lid **24**. Said shaft **26** is connected to an operating means **27** by means of which the shaft **26** may be brought to rotate. Said operating means **27** preferably constitutes an electric motor but also other types of operating means are possible within the scope of the invention. As is most evident from FIG. **3** an abutment **28** is provided inside the duct portion **21** of the valve means **11–14**. The opening defined by said abutment **28** is normally adapted to the shape of the damper **25**, i.e. if the damper **25** is circular, the opening defined by the abutment **28** is also preferably circular.

Means for measuring the pressure drop over the damper **25** is provided in the chamber **22**, said means being shown schematically in FIG. **2**. A first measuring means **29** measures the pressure of the ventilating air before the damper **25** while a second measuring means **30** measures the pressure of the ventilating air after the damper **25**. It is an essential benefit that the measuring of the air pressure takes place within the chamber **22**, i.e. inside the perforated sheet **23**. Thereby, an essentially absolute static air pressure is established that is not influenced by the turbulence of the air. Said first and second measuring means **29** and **30** respectively are connected to a registering means **31**, which in its turn is connected to the operating means **27** in order to activate said operating means **27** when the damper **25** is to be closed or its opening degree is regulated.

The Functional Mode of the Present Invention

With reference primarily to FIG. **4** the principle function of the invention will be described. However, initially reference is made to FIG. **1**, where the normal ventilating process is illustrated. In connection with said normal ventilating process the air pressure in the left portion of the valve means **11–14** is higher than the air pressure in the right portion, said ventilating air flowing according to the arrows **17–20**. The present invention is based on the principle to measure the direction of flow of the ventilating air.

If it is assumed that fire breaks out in the fire compartment **16** a high positive pressure is created in this fire compartment **16**, the consequence of this being that the air pressure at the right side of the valve means **12** will increase, which in its turn brings about that the air flow in direction of the arrow **18**, see FIG. **1**, decreases. This is equivalent with a decrease of the pressure drop over the damper **25**, said operating means **27** being adjusted in such a way that when the pressure drop has decreased to a certain predetermined limit value the operating means **27** is activated and the damper **25** is closed. In such a way it is avoided that fire gas of the inlet side is pressed into the duct system the reversed way via the second branch duct **5** for supply air.

In this connection it should be pointed out that of practical measuring reasons the damper **25** is closed when the pressure drop has such a magnitude that it can be registered by means of reasonably advanced measuring equipment, however the principle of the invention is still based on the supervision of the direction of flow of the air when the chosen pressure drop guarantees that the air flows in a certain direction.

At the outlet side of the fire compartment **16**, see arrow **20** in FIG. **4**, the fire gas is allowed to exit into the fourth branch duct **9** and further out into the main duct **10** of the exhaust air. However, fire gas will not enter into the fire compartment **15** the reversed way, via the valve means **13** in the first branch duct **7** of exhaust air. The reason therefore is that the increase of pressure that is generated in the main duct **10** for exhaust air, by the fire in the fire compartment **16**, will induce an increase of pressure in the right portion of the valve means **13**, this in its turn induces an increased resistance against the exhaust air that bypasses said valve means **13**. Thus, when the pressure drop over the valve means **13** has decreased to a certain predetermined value the damper **25** in the valve means **13** is closed in a corresponding way as the valve means **12**.

As is evident from the description above there is a straight connection between the direction of flow of the ventilating air through the valve means **11–14** and the pressure drop that is registered over said valve means **11–14**. To register the direction of flow of the ventilating air by measuring the pressure drop over a valve means is thus the basic principle of the present invention.

The above described structural design of the valve means **11–14** also allows that a sufficient pressure drop, in order to avoid closing of the damper **25**, is maintained over the valve means **11–14** also at a relatively moderate velocity of the ventilating air. With reference to FIGS. **5–7** a number of different operating conditions of the ventilating system according to FIGS. **1** and **4** will be illustrated. In this connection it should be pointed out that for all disclosed operating conditions a certain predetermined lowest pressure drop ΔP is present over the valve means **11–14**. The following formula is used in order to facilitate the understanding of the principle that the present invention is based upon:

$\Delta P=\rho \times v^2 \times \zeta$; where

ρ=the density of the air;

v=the velocity of the air before the valve means; and

ζ=coefficient of resistance of the valve means.

For all disclosed operating conditions the density on the air ρ is the same.

In connection with the operating condition of FIG. **5** the damper **25** is completely open, i.e. the coefficient of resistance ζ_1 is relatively seen low. In order to compensate for this, i.e. to achieve the lowest acceptable pressure drop ΔP, the air velocity v_1 must be, relatively seen, high. The operating condition disclosed in FIG. **5** illustrates the case when the ventilating system is operating at a high level, i.e. there is a high air circulation in the fire compartments **15** and **16**.

In the operating condition shown in FIG. **6** the damper **25** is somewhat more closed, i.e. restricted, than in the operating condition according to FIG. **5**. This means that the coefficient of resistance ζ_2 has a higher value than in the operating condition according to FIG. **5** and it is directly realized that the air velocity v_2 may be lower without going below the predetermined lowest pressure drop. The operating condition according to FIG. **6** is present when the ventilating system is operating at an intermediate level.

In the operating condition shown in FIG. **7** the damper **25** is further closed, i.e. restricted, compared to the operating condition according to FIG. **6**. This means that the coefficient of resistance ζ_3 has a higher value than the coefficient of resistance ζ_2 in the operating condition according to FIG. **6** and consequently the air velocity V_3 may be lower than the air velocity v_2 in the operating condition according to FIG. **6**. The operating condition according to FIG. **7** may for instance be present at night when the ventilating system is operating at a very low level.

Generally the air velocity v and the coefficient of resistance ζ has a direct mutual connection, i.e. a lower air velocity v must be compensated by a higher coefficient of resistance ζ and vice versa in order not to go below the lowest permitted pressure drop ΔP. In this connection it should also be considered that the formula given above includes the air velocity in square, and therefore a change in the air velocity has a higher penetration.

As is realized from the illustrated different operating conditions according to FIGS. **5–7** a certain opening degree of the damper **25** corresponds to a certain lowest air velocity and below this velocity the damper **25** moves to a more closed position. In this connection it should be considered that if for instance in the operating condition according to FIG. **6** the air velocity v_2 decreases below the predetermined value the damper **25** will move towards a closed position but since the coefficient of resistance increases the damper **25** will not close completely. The pending air velocity is for instance sufficient for the operating condition according to FIG. **7** and hence this operating condition is assumed, this in practice being what happens when the ventilating system transfers from operating at an intermediate level to operate at a low level. This mode of function is not negative as regards the security aspect of the described ventilating system. If it is assumed that a fire having a vigorous progress breaks out in the fire compartment **16** in FIG. **4** the pressure in said fire compartment **16** will quickly increase to such a level that the pressure drop for the ventilating air over the valve means **12** completely disappears or even becomes negative, i.e. the pressure at the side facing towards the fire compartment **16** of the valve means **12** is higher than the pressure at the side of the valve means **12** facing towards be main duct **1**. In such a case the damper **25** of the valve means **12** is of course completely closed since, as has been mentioned above, a lowest predetermined, in practice suitable, pressure drop ΔP may be 20 Pa.

The principle of the invention functions also at the situation when the ventilating systems transfers from operating at a low level, see FIG. **7**, to operate at an intermediate level, see FIG. **6**. In such a case the air velocity increases from V_3 to v_2, which means that the registered instantaneous pressure drop increases and the damper **25** is opened to the position according to FIG. **6**. At a further increased air velocity v_1 the damper **25** will be able to assume the position according to FIG. **5** without getting below the predetermined pressure drop.

In this connection it should also be pointed out that the use of the principle described above as regards the relationship between the air velocity and the coefficient of resistance ζ makes it possible that, in the same building, different fire compartments may be supplied air having different velocity. By regulating the restriction of the dampers **25** compensation can be achieved for a difference in air velocity, i.e. a pressure drop is maintained that is higher than the predetermined pressure drop.

In FIGS. **8–11** an alternative embodiment of a valve means **11'–14'** is shown, i.e. said valve means **11'–14'** may replace the valve means **11–14** in the embodiment described above. As is evident from FIGS. **8–11** the valve means **11'–14'** constitutes a combined single leaf damper and slide damper, said damper comprising a frame **32'** that in its turn comprises to parallel sheets **33'** and **34'** that between themselves define a space. The damper itself constitutes a leaf **25'** that is pivotally received in said space between the sheets **33'** and **34'**. The leaf **25'** is connected to a pivot pin **27'** that in the disclosed embodiment extends through one sheet **34'**. Said pivot pin **27'** is in its turn connected to a motor or other power source (not shown), the pivot pin **27'** and the motor having principally the same function as the operating means **27** according to the embodiment described above. Thus, the non-disclosed motor may turn the pin **27'** and hence the leave **25'** around the point where the pin **27'** penetrates the sheet **34'**. When displacing the leave **25'** the sheets **33'** and **341** serve as guides for the leaf **25'**.

On each of the sheets **33'** and **34'** a spigot **36'** is provided, said spigot **36'** being connected to a corresponding opening in the adherent sheet **33'**, **34'**. The spigots **36'** are located opposite to each other and adapted to be connected to air ducts in the ventilating system where the valve means **11'–14'** is installed.

The reasoning, carried out above in connection with the embodiment described above, as regards the function of the present invention at different operating conditions, i.e. that a sufficient pressure drop may be maintained over the valve means **11–14** in order to prevent closing of the damp to **25** also at a relatively moderate velocity of the ventilating air, is pertinent also for the alternative embodiment of the valve means **11'–14'** disclosed in FIGS. **8–11**. The operating condition shown in FIG. **9**, having the air velocity v_1, corresponds to the operating condition shown in FIG. **5**, the operating condition shown in FIG. **10**, having the air velocity v_2, corresponds to the operating condition shown in FIG. **6** and the operating condition shown in FIG. **11**, having the air velocity V_3, corresponds to the operating condition shown in FIG. **7**. In order to achieve the different operating conditions, schematically illustrated in FIGS. **8–10**, the leaf **25'** is displaced in such a way that it to a varying degree covers the through flowing area of the air that passes the valve means **11'–14'**.

As regards registering of the pressure drop over the valve means **11'–14'**, this can be effected by a principally corresponding means as schematically is shown in FIG. **2**.

To a sum up it should be pointed out that the basic principle of the present invention is that the flow path of the ventilating air is blocked when a certain lowest, predetermined pressure drop is measured over a measuring spot that normally constitutes a damper or the like. In its most simple design this damper may only assume two positions, i.e. opened or closed.

Feasible Modifications of the Invention

In connection with the function described above it is assumed that the damper **25** is adjusted automatically in correspondence to the measured pressure drop ΔP over the valve means **11–14**, i.e. that the operating means **27** in a suitable way is connected to the registering means **31**. However, within the scope of the invention it is also feasible that the adjustment of the dampers **25** is carried out manually, i.e. when the velocity in the system is decreased the dampers **25** are restricted, the degree of restriction being achieved empirically.

According to the embodiments described above the area regulating means constitute different types of single leaf dampers and slide dampers **25**; **25**'. However, within the scope of the present invention it is feasible to have different types of dampers or other structural designs of the area regulating means.

The device according to the present invention may of course be completed by a fire thermostat or the like in order to protect against fire distribution.

In order to achieve an extremely reliable indication that the damper **25**; **25**' has assumed its closed position when the predetermined pressure drop is registered said damper **25**; **25**' may be brought to actuate a micro switch in connection with the attaining of said closed position.

What is claimed is:

1. Device for preventing distribution of fire gases in a ventilating system that serves a number of fire compartments having an inlet side and an outlet side, said ventilating system comprising inlet ducts for supplying ventilating air to the fire compartments and outlet ducts to exhaust ventilating air from the fire compartments, such that the ventilating air, during normal operating conditions, has a certain predetermined direction of flow at the inlet side and the outlet side of said fire compartments;

valve means being provided in the inlet ducts and the outlet ducts in connection with said fire compartments;

said valve means comprising means for regulating a flowing area of the ventilating air;

wherein the device comprises means for registering, over a measuring spot in connection with said flowing area regulating means, an instantaneous pressure drop of the ventilating air in said predetermined direction of flow, and operating means for each flowing area regulating means; said operating means, in connection with registration of a predetermined lowest pressure drop for the ventilating air over said measuring spot, being adapted to actuate the adherent area regulating means to block the flowing area of the ventilating air past said measuring spot.

2. The device according to claim **1**, wherein the means for registering the instanteaneous pressure drop cooperate with the operating means in such a way that a decrease of the pressure drop results in a decreased opening degree of the flowing area regulating means, and an increase of the pressure drop results in an increased opening degree of the flowing area regulating means.

3. The device according to claim **1**, wherein the flowing area regulating means comprises dampers.

4. The device according to claim **1**, further comprising a chamber provided in connection with each of the valve means; said chamber being screened off from the turbulence of the flowing ventilating air, and the means for registering the pressure drop over the measuring spot are connected to said chamber.

5. The device according to claim **4**, wherein a the screening of the chamber is carried out by a perforated sheet.

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